

PATENT ABSTRACTS OF JAPAN

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(54) RIGID CARBON FILM MOLDED PRODUCT

(57)Abstract:

PROBLEM TO BE SOLVED: To improve durability under highly loading by coating a rigid carbon film (a diamond-like carbon film) on the surface of a steel base metal by putting a WC film between them.

SOLUTION: At first a WC film 2 is formed on a surface of a steel base material 1, and a rigid carbon film 3 is formed on the WC film 2. The steel base metal is martensitic stainless steel, precipitation hardening stainless steel or SUJ2, M50, etc., and the WC film 2 is formed by using, for example, a magnetron sputtering apparatus. Further, the rigid carbon film 3 is formed by an ion plating method wherein, for example, hydrocarbon gas is introduced into a vacuum vessel, d.c. voltage is impressed between two poles of electrodes to generate glow discharge, and coating treatment is carried out under the discharge. When the WC film is made to lie as an intermediate layer between the rigid carbon film 3 and the steel base metal 1, adhesion is improved.



LEGAL STATUS

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CLAIMS

[Claim(s)]

[Claim 1] The hard carbon film Plastic solid which covered the hard carbon film on both sides of WC film on the front face of a steel base material.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the hard carbon film Plastic solid applicable to a slide member or anti-friction bearing which covered the hard carbon film (diamond-like carbon film) on the front face of a steel base material.

[0002]

[Description of the Prior Art] Conventionally, the skid components of which endurance is required by the Takani pile, and rolling and covering the hard carbon film with components on the front face of a steel base material are performed.

[0003] However, when the direct hard carbon film is covered on the front face of a steel base material, there is a problem that the hard carbon film exfoliates from the front face of a steel base material, by the difference in coefficient of thermal expansion etc.

[0004] For this reason, what the adhesion of a steel base material and the hard carbon film tends to be improved, and it is going to raise the endurance in the Takani pile for is proposed by making the middle class of an organic silicon compound or a SiC system intervene between a steel base material and the hard carbon film conventionally (JP,7-41779,A).

[0005] However, this conventional thing also still has the inadequate endurance in the Takani pile.

[0006] Then, this invention tends to raise the endurance in the Takani pile further rather than the conventional thing.

[0007]

[Means for Solving the Problem] This invention makes WC film intervene between a steel base material and the hard carbon film.

[0008] Thus, as an interlayer of a steel base material and the hard carbon film, if WC film is made to intervene, rather than the conventional thing which uses the thing of a SiC system as an interlayer, adhesion will improve and the endurance in the Takani pile will improve. This is SiO₂ in addition to SiC, when carrying out coat processing of the thing of a SiC system. The coat of the included gauche form voice is formed, to it being surmised that this has had the bad influence on adhesion, by coat formation of WC, a coat is obtained and only WC is conjectured to be because for the oxide film which has a bad influence on adhesion not to be formed.

[0009]

[Embodiment of the Invention] In this invention, martensitic stainless steel, precipitation hardening stainless steels, or ferrous materials, such as SUJ2 and M50, are used as a steel base material.

[0010] And in this invention, as shown in drawing 1, on the front face of this steel base material 1, first, the WC film 2 is formed and the hard carbon film 3 is formed on this WC film 2.

[0011] The WC film 2 can be formed for example, using magnetron spalling equipment.

[0012] Moreover, the hard carbon film 3 introduces hydrocarbon system gas for example, in a vacuum housing, impresses direct current voltage to inter-electrode [of two poles], generates glow discharge, and can be formed by the ion plating method for performing coat processing under the discharge.

[0013] [Example] -- coat processing of the WC fine particles is carried out with a magnetron sputtering system (input power 150-250W at the time of processing), and the interlayer of WC film of 0.1 micrometers or less of thickness is formed in the front face of the steel base material of a phi50mm disk mold.

[0014] Subsequently, it is C two H2 with an ion plating system on the above-mentioned middle class. The hard carbon film before and behind 0.5 micrometers of thickness is formed using gas (acetylene). The electrical potential difference at the time of processing is -1.2kV.

[0015] A pinion disk mold friction abrasion tester is used about what formed WC film in the interlayer who formed as mentioned above, and the thing which formed the SiC film or the SiC film by the organic silicon compound in the interlayer, and the result of having performed durability test is shown at drawing 2. A test condition is as being shown in Table 1.

[0016]

[Table 1]

試 験 条 件

ピ ン	S U S 4 4 0 C 製 5 / 1 6 " 鋼 球 (無 処 理)		
デ ィ ス ク	$\phi 50 \times \phi 8.1 \times t 7$ (被 膜 処 理)		
デ ィ ス ク 材 質	S U J 2 、 S U S 4 4 0 C 、 S K H 4		
雰 囲 気	大 気 中		
荷 重 , N	9.81	す べ り 速 度 , m / s	1.0
試 験 時 間 , min	$\mu = 0.35$ に 達 す る ま で の 時 間		

[0017] If the middle class is used as WC film, in each ferrous material, the endurance of the hard carbon film will increase remarkably, so that clearly from drawing 2.

[0018] Next, the result of having compared the atmospheric-air raising dust property is shown in drawing 3 about the bearing of the angular form where the quality of the material of an inside-and-outside ring made WC film of 0.1 micrometers or less of thickness intervene, and covered the hard carbon film before and behind 0.5 micrometers of thickness with SUS440C on the front face, and the thing whose interlayer is a SiC system. A test condition is as in Table 2.

[0019]

[Table 2]

試 験 条 件

雰 囲 気	大 気 中		
回 転 数 , rpm	50	荷 重 (F a) , N	9.81
時 間 , h	150		
測 定 粒 子 径 , μm	≥ 0.3		

[0020] The amount of atmospheric-air raising dust is falling by using an interlayer as WC film so that clearly from drawing 3. Moreover, although film peeling after a test was not generated when an interlayer was used as WC film, in the case of the SiC system, film peeling had occurred in part. There is little total number of the amount of atmospheric-air raising dust in the case of using WC film as 500 or less pieces, and generating of dust like a clean room can be referred to as suitable for anti-friction bearing used under a ***** environment.

[0021]

[Effect of the Invention] Since the hard carbon film Plastic solid of this invention inserts WC film into the front face of a steel base material and has covered the hard carbon film, the hard carbon film cannot

exfoliate easily and its endurance in the Takani pile is good.

[Translation done.]

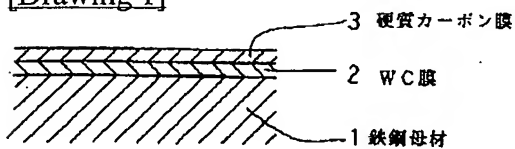
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DRAWINGS



[Drawing 1]



[Drawing 2]

耐 久 性 試 験		
ディスク材質	中 間 層	耐久性 (すべり距離) $\times 10^3$ m
S U J 2	W C	85
	S i C	45
	有機シリコン化合物	5
S U S 440 C	W C	75
	S i C	55
	有機シリコン化合物	50
S K H 4	W C	80
	S i C	45
	有機シリコン化合物	50

[Drawing 3]

中 間 層	大気汚染量(0.3μm以上／1c fの総個数、個)	
	500	1000
W C		
S i C		

[Translation done.]

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EFFECT OF THE INVENTION

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TECHNICAL PROBLEM

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[0003] However, when the direct hard carbon film is covered on the front face of a steel base material, there is a problem that the hard carbon film exfoliates from the front face of a steel base material, by the difference in coefficient of thermal expansion etc.

[0004] For this reason, what the adhesion of a steel base material and the hard carbon film tends to be improved, and it is going to raise the endurance in the Takani pile for is proposed by making the middle class of an organic silicon compound or a SiC system intervene between a steel base material and the hard carbon film conventionally (JP,7-41779,A).

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MEANS

[Means for Solving the Problem] This invention makes WC film intervene between a steel base material and the hard carbon film.

[0008] Thus, as an interlayer of a steel base material and the hard carbon film, if WC film is made to intervene, rather than the conventional thing which uses the thing of a SiC system as an interlayer, adhesion will improve and the endurance in the Takani pile will improve. This is SiO₂ in addition to SiC, when carrying out coat processing of the thing of a SiC system. The coat of the included gauche form voice is formed, to it being surmised that this has had the bad influence on adhesion, by coat formation of WC, a coat is obtained and only WC is conjectured to be because for the oxide film which has a bad influence on adhesion not to be formed.

[0009]

[Embodiment of the Invention] In this invention, martensitic stainless steel, precipitation hardening stainless steels, or ferrous materials, such as SUJ2 and M50, are used as a steel base material.

[0010] And in this invention, as shown in drawing 1, on the front face of this steel base material 1, first, the WC film 2 is formed and the hard carbon film 3 is formed on this WC film 2.

[0011] The WC film 2 can be formed for example, using magnetron spalling equipment.

[0012] Moreover, the hard carbon film 3 introduces hydrocarbon system gas for example, in a vacuum housing, impresses direct current voltage to inter-electrode [of two poles], generates glow discharge, and can be formed by the ion plating method for performing coat processing under the discharge.

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EXAMPLE

[Example] -- coat processing of the WC fine particles is carried out with a magnetron sputtering system (input power 150-250W at the time of processing), and the interlayer of WC film of 0.1 micrometers or less of thickness is formed in the front face of the steel base material of a phi50mm disk mold.

[0014] Subsequently, it is C two H2 with an ion plating system on the above-mentioned middle class. The hard carbon film before and behind 0.5 micrometers of thickness is formed using gas (acetylene). The electrical potential difference at the time of processing is -1.2kV.

[0015] A pinion disk mold friction abrasion tester is used about what formed WC film in the interlayer who formed as mentioned above, and the thing which formed the SiC film or the SiC film by the organic silicon compound in the interlayer, and the result of having performed durability test is shown at drawing 2. A test condition is as being shown in Table 1.

[0016]

[Table 1]

試 験 条 件

ピ ン	SUS440C製5/16" 鋼球（無処理）		
ディスク	φ50×φ8.1×t7（被膜処理）		
ディスク材質	SUJ2、SUS440C、SKH4		
雰囲気	大気中		
荷重, N	9.81	すべり速度, m/s	1.0
試験時間, min	μ=0.35に達するまでの時間		

[0017] If the middle class is used as WC film, in each ferrous material, the endurance of the hard carbon film will increase remarkably, so that clearly from drawing 2.

[0018] Next, the result of having compared the atmospheric-air raising dust property is shown in drawing 3 about the bearing of the angular form where the quality of the material of an inside-and-outside ring made WC film of 0.1 micrometers or less of thickness intervene, and covered the hard carbon film before and behind 0.5 micrometers of thickness with SUS440C on the front face, and the thing whose interlayer is a SiC system. A test condition is as in Table 2.

[0019]

[Table 2]

試 験 条 件

雰囲気	大気中		
回転数, rpm	5 0	荷重 (F a) , N	9. 8 1
時間, h	1 5 0		
測定粒子径, μm	$\geq 0. 3$		

[0020] The amount of atmospheric-air raising dust is falling by using an interlayer as WC film so that clearly from drawing 3 . Moreover, although film peeling after a test was not generated when an interlayer was used as WC film, in the case of the SiC system, film peeling had occurred in part. There is little total number of the amount of atmospheric-air raising dust in the case of using WC film as 500 or less pieces, and generating of dust like a clean room can be referred to as suitable for anti-friction bearing used under a ***** environment.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The fragmentary sectional view of the hard carbon film Plastic solid of this invention

[Drawing 2] The graph which shows the result of a durability test

[Drawing 3] The graph which shows the result of an atmospheric-air raising dust characteristic test

[Description of Notations]

1 Steel Base Material

2 WC Film

3 Hard Carbon Film

[Translation done.]

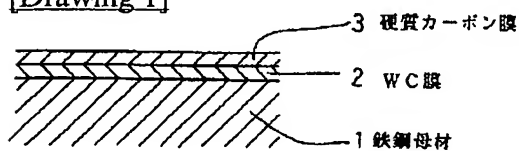
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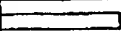
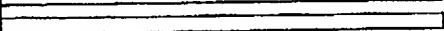
[Drawing 1]



[Drawing 2]

耐久試験		耐久試験	
ディスク材質	中間層	耐久性(すべり距離) × 10 ³ m	
		0	20 40 60 80 90
SUJ2	WC		
	SiC		
	有機リソ化合物		
SUS440C	WC		
	SiC		
	有機リソ化合物		
SKH4	WC		
	SiC		
	有機リソ化合物		

[Drawing 3]

中 間 層	大気汚染量(0.3 μ m以上/l c f の総個数、個)	
	500	1000
W C		
S i C		

[Translation done.]